The Mercury Dust Experiment (MDEX) [#6001]

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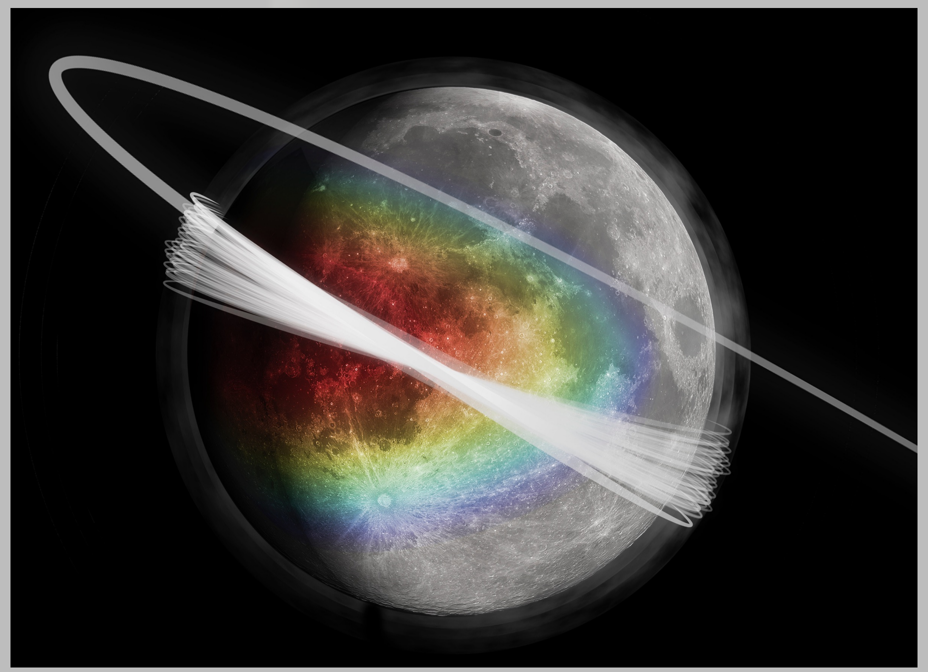
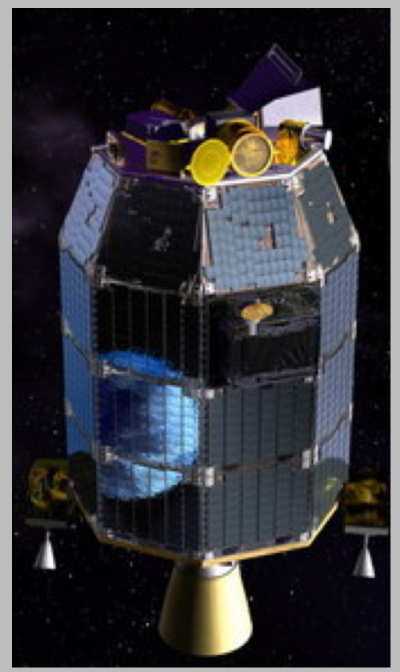
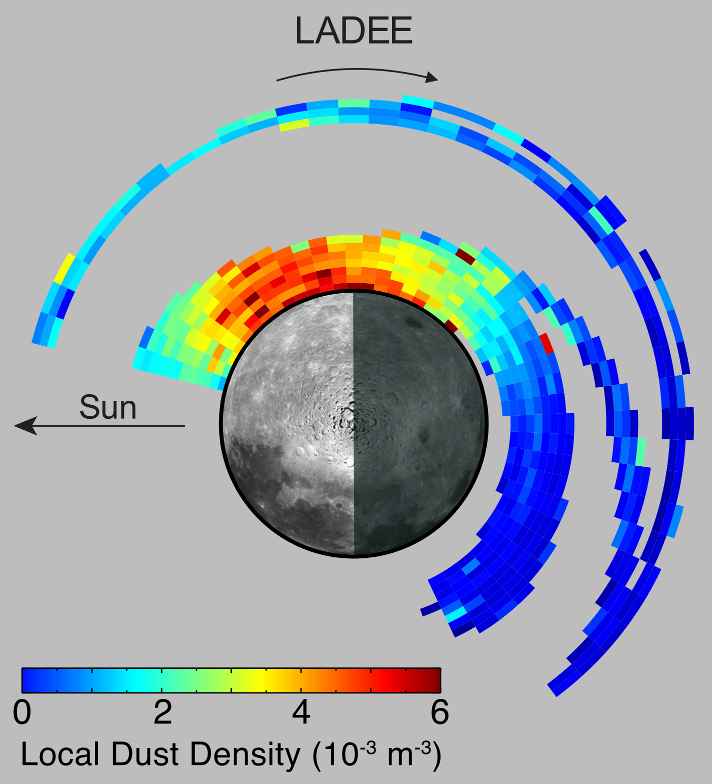
Abstract: The bombardment of airless planetary bodies plays a significant role in shaping their surface properties and contributes to sustaining their tenuous atmospheres. The Lunar Dust Experiment (LDEX) onboard the LADEE mission highlighted the role of dust impacts as sources of several atmospheric species by correlating the simultaneous measurements of LDEX with the observations by UVS and NMS instruments. Similar measurements in orbit about Mercury will characterize the effects of dust impacts that are expected to be even more dramatic than at the Moon, due to the much larger impact speeds of the bombarding meteoroids. **MDEX**, an updated version of LDEX, in addition to the size distribution of the ejected dust particles, could also measure their composition and map the surface composition of Mercury. This is an especially attractive opportunity to investigate the volatile content in permanently shadowed regions where optical remote sensing is not viable.

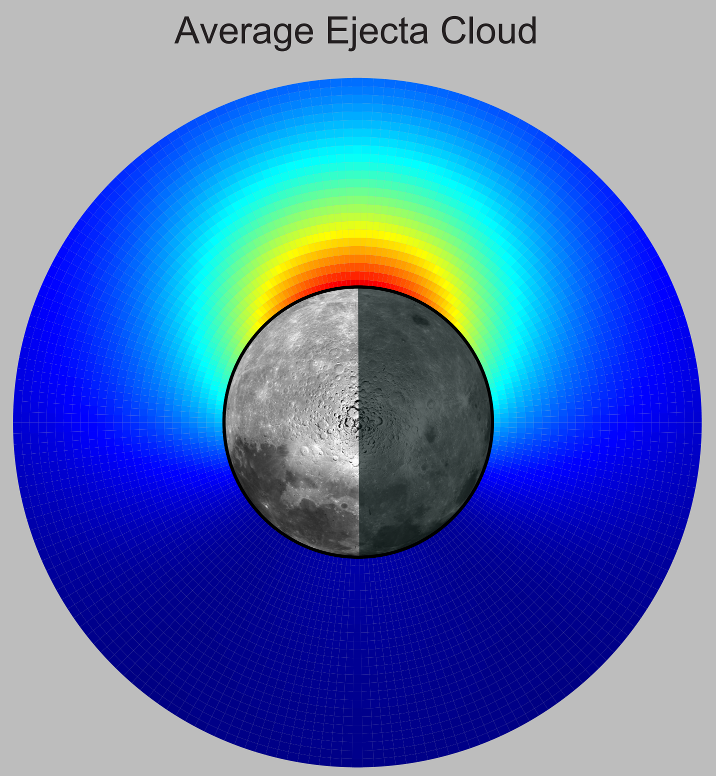
The Lunar Atmosphere and Dust Environment Explorer (LADEE): mission was launched in September 2013. It reached the Moon in about 30 days, continued with an instrument checkout period of about 40 days at an altitude of 220-260 km, followed by approximately 150 days of scientific observations at a typical altitude of 20-100 km. LADEE followed a near-equatorial retrograde orbit, with a characteristic orbital speed of 1.6 km/s.



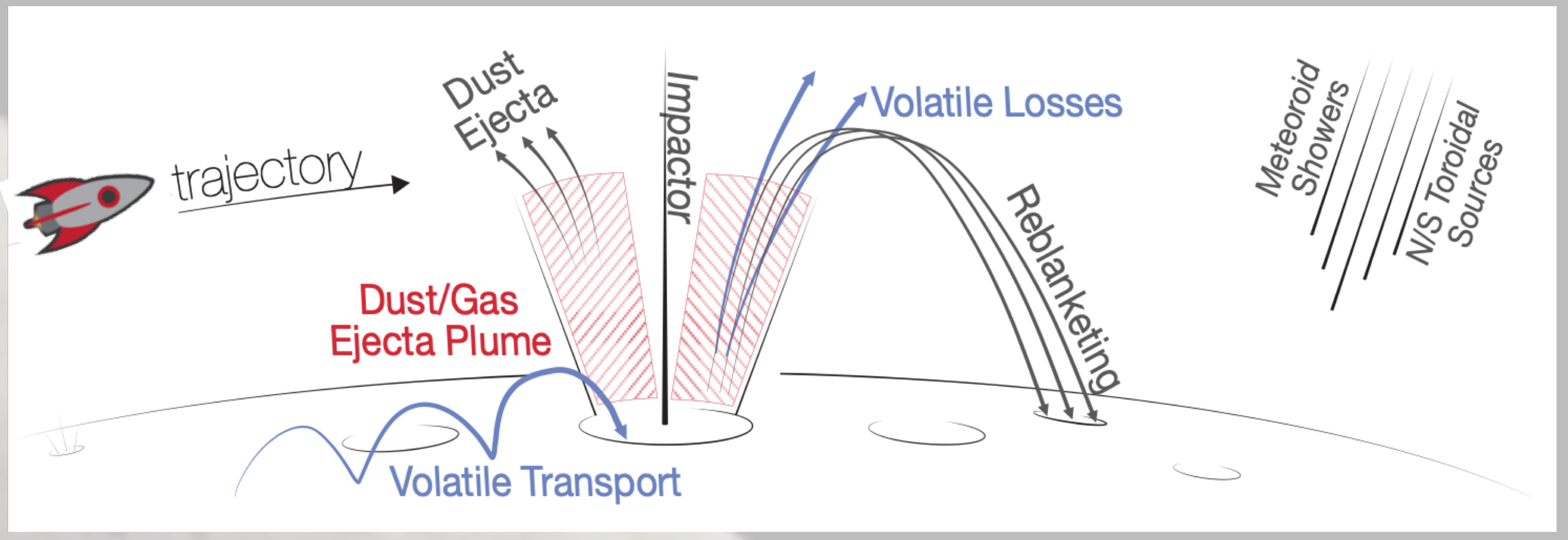


The Lunar Dust Experiment (LDEX): was designed to explore the ejecta cloud generated by sporadic interplanetary dust impacts, including possible intermittent density enhancements during meteoroid showers, and to search for the putative regions with high densities of dust particles with radii <1 μm lofted above the terminators. LDEX was an impact ionization dust detector, which measures both the positive and negative charges of the plasma cloud generated when a dust particle strikes its target. The amplitude and shape of the waveforms (signal versus time) recorded from each impact are used to estimate the mass of the dust particles. The instrument had a total sensitive area of 0.01 m^2, gradually decreasing to zero for particles arriving from outside its dust field-of-view of 68^0 off from the normal direction. The measured fluxes indicate that the Moon is engulfed in a permanently present but highly variable dust exosphere.





$$n(h, \varphi, a) = e^{-h/\lambda} \left(\frac{a}{a_{\rm th}}\right)^{-3\alpha} \underbrace{n_w \sum_s w_s \cos^3(\varphi - \varphi_s)\Theta(|\varphi - \varphi_s| - \pi/2)}_{n_0(\varphi)}$$



MDEX for compositional mapping of Mercury's surface: The dust particles comprising the ejecta cloud are small samples from the surface and could be used to map the chemical composition of Mercury from orbit, using MDEX, an updated LDEX instrument, a dust impact ionization time-of-flight spectrometer.

Summary: Mercury, as all airless planetary bodies, is continually bombarded by interplanetary micrometeoroids. It is expected to be engulfed in a permanently present dust exosphere that changes with time and location. The ejecta particles are samples from the surface and provide an opportunity to map the surface composition, including the permanently shadowed regions.